SCI 355B: Lecture 2
Importance, Diversity, and Conservation

What is entomology?

• **Entomology** - the study of insects.
  - Modern study commenced in 18th century with the advent of ground glass optics.
• **Entomologists** - people who study insects
  - Observe, collect, rear, experiment
  - Evolution, ecology, behavior, anatomy, physiology, biochemistry, genetics
  - Charles Darwin’s initial enthusiasm in natural history was as a collector of beetles
• **Ideal research subjects** - culturing in a laboratory, life span, many individuals, minimal ethical concern.

The importance of insects

• Ecologies are incredibly varied
• Dominate food chains in both volume and numbers
• Feeding specializations
  - Detritus (e.g., leaf litter)
  - Rotting materials
  - Living and dead wood
  - Fungus
  - Aquatic filter feeding and grazing
  - Herbivory = phytophagy, including sap
  - Predation and parasitism
The importance of insects

- Live in water, on land, or in soil, during part or all of their lives
- Lifestyles may be solitary, gregarious, or social
- Mimic objects or other organisms, conspicuous, or concealed.
- May be active by day or by night or both
- Lifestyles facilitate survival under a wide range of conditions: extreme heat/cold, wet/dry

Insects are essential to the following ecosystem functions:

- **Ecosystem**—that combined physical and biological components of an environment
- Nutrient recycling, via leaf litter and wood degradation, dispersal of fungi, disposal of carrion and dung, and soil turnover
- Plant propagation, including pollination and seed dispersal.
- Maintenance of plant community composition and structure, via **Phytophagy**, including seed feeding.

Insects are essential to the following ecosystem functions

- Food for insectivorous vertebrates, such as many birds, mammals, reptiles, and fish.
- Maintenance of animal community structure, through transmission of diseases of large animals, and predation and parasitism of smaller ones.
- Each insect species is part of a greater assemblage and its loss affects the complexities and abundance of other organisms. Such insects are considered **keystone species** because loss of their critical ecological functions could collapse and the wider ecosystem.
Insects are associated intimately with our survival

- can damage the health of humans, domestic animals
- Can adversely affect our agriculture and horticulture
- Certain insects greatly benefit human society, either by providing us with food directly or by contributing to our food or materials that we use.

Importance of insects

- containing a vast array of chemical compounds, some of which can be collected, extracted, or synthesize for our use.
  - e.g., chitin, a component of insect cuticle, and its derivatives act as anticoagulants, enhance wound and burn healing, reduce serum cholesterol, provide strong biodegradable plastics, and enhance removal of pollutants from wastewater

Diversity & Classification
“And out of the ground the Lord God formed every beast of the field, and every fowl of the air; and brought them unto Adam to see what he would call them: and whatsoever Adam called every living creature, that was the name thereof. And Adam gave names to all cattle, and to the fowl of the air, and to every beast of the field….” (Genesis 2: 19-20)

Classification of Organisms

Why classify?

- Humans like to collect and study things
- Collection usually must be accompanied by classification
- To study anything, we must have a system of names - “nomenclature”
- No name gives you no information, a wrong name gives you the wrong information
- Scientific uniformity
- Communication

History of Classification of Living Organisms

Aristotle

*4th century BC (384 to 322 BC)
*Greek philosopher
*divided organisms into 2 groups - plants and animals
*divided animals into blood and bloodless
*also divided animals into 3 groups according to how they moved: walking, flying, or swimming (land, air, or water)
*his system was used into the 1600's
*Historia Animalium
What system do we use?

- **SIMILARITY** is the basis for all classifications
- In the case of living organisms, **Morphology/Anatomy**

- Animal and plant classification developed by Carolus Linneaus (b. 1707, Sweden).
- **Binomial Nomenclature**: Genus & Species
  - (bi = two; nome = name)
- **Hierarchical System of classification**
  - bottom up NOT top down
  - The right name is the first step to studying any organism

**Homo sapiens:** “Wise one”

**Homo**

Hominidae

Primates

Mammalia

Chordata

Animalia

Eukarya

Species - a group whose members possess similar anatomical characteristics and have the ability to interbreed (Biological Species Concept)

<table>
<thead>
<tr>
<th>Biological Organization</th>
<th>Military Organization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kingdom (one or more phyla)</td>
<td>Brigade (two or more regiments)</td>
</tr>
<tr>
<td>Phylum (one or more classes)</td>
<td>Regiment (two or more battalions)</td>
</tr>
<tr>
<td>Class (one or more orders)</td>
<td>Battalion (two or more companies)</td>
</tr>
<tr>
<td>Order (one or more families)</td>
<td>Company (two or more platoons)</td>
</tr>
<tr>
<td>Family (one or more genera)</td>
<td>Platoon (two or more squads)</td>
</tr>
<tr>
<td>Genus (one or more species)</td>
<td>Squad (a group of 12 soldiers)</td>
</tr>
<tr>
<td>Species (a distinct kind or unit)</td>
<td>Soldier (a distinct kind or unit)</td>
</tr>
</tbody>
</table>
**Systematics**

- **Systematics** - the science dealing with the diversity of organisms and of any and all relationships among them
- 3 Goals
  - Discover and name all species
  - Determine how organisms are related
  - Classify organisms into groups based on their relationships

**Animal Form**

4 evolutionary innovations in animal form

1. Single celled to multicelled. All multicellular animals called **METAZOA**
2. Body symmetry: no symmetry (e.g., sponges), radial symmetry (called **RADIATA**) (e.g., jellyfish), and bilateral symmetry (e.g., frog) (called **BILATERIA**)
3. Body cavities
4. Cleavage patterns (embryonic development)- all animals exhibit one of two different types of cleavage: spiral and determinate cleavage (**protostomes**) or radial and indeterminate cleavage (**deuterostomes**
Body Symmetry

(a) Radial symmetry

(b) Bilateral symmetry

Body Cavities of the Bilateria

Radial animals lack body cavities

3 groups of Bilateria

Coelom = body cavity

1) Acoelomates: no true body cavity, “space” filled with mesoderm

2) Pseudocoelomates: have a body cavity, but gut not lined with mesoderm

3) Coelomates: have a body cavity + gut lined with mesoderm

A comparison of early development in protostomes and deuterostomes

Embryonic tissues called germ layers

Ectoderm
Endoderm
Mesoderm
Phylum Arthropoda
“jointed foot”

- Most successful group of animals (~85% of all animal species)
- World-wide distribution every type of habitat
- Predators, parasites, scavengers, herbivores
- Economically important: food (shrimp, crabs, lobsters), agriculture and livestock pests, transmit diseases to humans, livestock, and pests, beneficial (pollinators, nutrient cycling)

Characteristics of Arthropods
- Exoskeleton composed of chitin, a nitrogenous polysaccharide
- Segmented bodies
- Exhibit tagmosis
- Jointed appendages used for locomotion and feeding
- Ventral (=chest) nerve cord and dorsal (=back) brain
- Complete digestive system (mouth to anus)
- Open circulatory system, blood=hemolymph (no veins or arteries)
- Growth by molting
- Metamorphosis often exhibited
Advantages of an Exoskeleton (a suit of armor)

1. Reduced $H_2O$ loss
2. Provides numerous sites for muscle attachment
3. Protection
   - mechanical
   - pathogens

Consequences of an Exoskeleton

- Must shed skin, i.e. molt, to grow
- vulnerable
- gas exchange

Consequences of an Exoskeleton

Weight is limiting - largest crustaceans must live in ocean to support their weight

Hercules beetle
• The diversity and success of arthropods is largely due to three features: body segmentation, a hard exoskeleton, and jointed appendages.
• Groups of segments and their appendages have become specialized for a variety of functions, permitting efficient division of labor among regions.

Tagmosis - the organization of body segments into regions

<table>
<thead>
<tr>
<th>Insects &amp; Crustaceans</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cephalothorax</td>
</tr>
<tr>
<td>Head</td>
</tr>
<tr>
<td>Thorax</td>
</tr>
<tr>
<td>Abdomen</td>
</tr>
<tr>
<td>Coordination</td>
</tr>
<tr>
<td>Vision</td>
</tr>
<tr>
<td>Feeding</td>
</tr>
<tr>
<td>Locomotion</td>
</tr>
<tr>
<td>Reproduction</td>
</tr>
</tbody>
</table>

Arachnida (~65,000 species)

1. Cephalothorax and abdomen
2. No antennae or wings
3. 4 pairs of legs in adults
4. 1 pair mouthparts - chelicerae
5. 1 pair pedipalps
6. Predators, herbivores, scavengers, & parasites

- scorpions
- ticks
- spiders
- harvest man spiders
- Cat fur mite
The arachnid cephalothorax has six pairs of jointed appendages:
- There are four pairs of walking legs.
- A pair of pedipalps function in sensing or feeding.
- The chelicerae usually function in feeding.
- Spiders inject poison from glands on the chelicerae to immobilize their prey and while chewing their prey, spills digestive juices into the tissues and sucks up the liquid meal.

Crustacea (~42,000 species)
1. Head, thorax, & abdomen, or cephalothorax & abdomen
2. Usually 2 pairs of antennae
3. 5 or more pairs of walking legs
4. Most aquatic, some terrestrial predators, herbivores or scavengers

- Barnacles, crabs, lobsters, & shrimp
- Crayfish
- Amphipods
- Pill bugs/sowbugs
Diplopoda (millipedes) (~7,500 species)

1. Body with head and many-segmented trunk
2. 1 pair of antennae
3. Trunk with 2 pairs legs/segment
4. Terrestrial - damp areas under stones, logs, & in soil
5. Many species secrete foul-smelling fluid to defend against predation

Jon Fouskaris

Chilopoda (centipedes) (~3,000 species)

1. Body with head and 15-177 trunk segments
2. 1 pair of antennae
3. Trunk segments have 1 pair legs
4. First segment - poison legs (jaws)
5. Terrestrial, prey on insects, spiders, & other small animals - found under stones & logs